EFFECT OF GROWTH MINDSET BASED INTERVENTION ON SCIENCE ANXIETY AND ACADEMIC STRESS OF SECONDARY LEVEL STUDENTS

Synopsis

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1.0 Introduction

Whether talent is God gifted or it could be developed? It is a question that has no unanimously accepted answer yet. Some similar questions are that – whether personality and intelligence could be developed or they are fixed traits. It is commonly believed that intelligence is innate and genetic but scientific research unveiled the fact that intelligence is neither solely innate nor genetic; it can be taken to a higher level with hard labour and effort. Appropriate stimuli to the brain by learning something new, getting some new experiences, or repeated practice of something give rise to the formation of new neurons and the new interconnections between the neurons (Demarin et al., 2014); the phenomenon is termed brain plasticity. Personality, intelligence, and talent are the conscious outcomes of brain activity. The concept of brain plasticity gives an obvious clue that the conscious outcomes of brain activity (personality, intelligence, and talent) can also be changed. The belief in malleable personality, intelligence, talent, ability, or skill is termed as growth mindset in general and the belief in malleable intelligence is known as the growth mindset of intelligence. A mindset intervention was found to produce a more convincing effect on the malleability of intelligence with an enduring beneficial change of attitudes about intelligence (Aronson et al., 2002), and in another study mindset intervention was found to produce a significant effect on poorly performing 'at risk students' (Paunesku et al., 2015).

The two dependent variables understudy science anxiety and academic stress negatively affects learning and learning outcomes. The students having a growth mindset belief are likely to have an optimistic view toward improving their intelligence and academic abilities, it will develop strong self-confidence in them so they will be less prone to anxiety, and will perceive less stress in the academic setting. Unfortunately, the growth mindset research has not paid enough attention to the effect of the growth mindset on these mental health-related factors. The proposed research work will contribute to filling this research gap. This study will investigate the effect of a subject-specific, lesson-integrated growth mindset-based intervention on science anxiety and academic stress of secondary-level science students.

1.1 Growth mindset

The own beliefs and the framed self-theories developed by an individual to interpret the worldly things

around them are collectively known as implicit theories. Carol Dweck and co-workers propounded that people also have implicit theories of intelligence – entity theory of intelligence and incremental theory of intelligence (Dweck & Leggett, 1988). Later the names entity theory and incremental theory were changed to more user-friendly terms of fixed and growth mindsets (Dweck & Yeager, 2019). Carol Dweck proposed a synthesis of the 'Growth Mindset' (Dweck, 2006). Growth mindset theory conceptualizes that so believed innate talents and abilities like intelligence and skills are malleable (i.e. flexible) and dynamic (i.e. changeable) in nature. The people having an entity theory of intelligence are in a fixed mindset and they believe that intelligence is a fixed innate trait and cannot be changed whereas the people having an incremental theory of intelligence are in a growth mindset and believe that intelligence can be changed and improved. A growth mindset theory believes that – (i) Intelligence and talents can be developed and improved (ii) The continuous effort led to mastery (iii) Mistakes are part of the improvement effort (iv) Mistakes provide a chance to see the actual answer, thus assimilating the new information with previous knowledge (v) Failures are essential in process of learning and during achieving goals, these are temporary setbacks (vi) Both the mistakes and failures generate the biggest opportunities to learn (vii) Accepting challenges grow intelligence.

The growth mindset has been shown to influence internal belief states like motivation, goals, and behaviour as well, as retention, self-efficacy, enjoyment and /or engagement, interest in academics, and perceived cognitive load (Bedford, 2017; Burnette, Hoyt, et al., 2020; Mosanya, 2021; Rhew et al., 2018; Samuel & Warner, 2021; Sarrasin et al., 2018; Xu et al., 2021) and it improves the learning outcomes (Bettinger et al., 2018; Blackwell et al., 2007; Romero et al., 2014; Yeager et al., 2019).

In some recent studies, the growth mindset intervention is found not so effective in improving academic attainment but found effective in improving mindset beliefs (Brougham & Kashubeck-West, 2017; Burnette, Hoyt, et al., 2020; de Carvalho & Skipper, 2020; Orosz et al., 2017).

Some of the studies did not replicate (Ganimian, 2020; Li & Bates, 2019) the positive results of the growth mindset and two recent meta-analyses did not support (Costa & Faria, 2018; Sisk et al., 2018) the growth mindset theory. Such findings float an important question why does mindset predicts academic outcomes in some cases but not in others and is the theory of growth mindset effective on some other non-academic factors important for learning and what are those factors?

In a recent publication (Yeager & Dweck, 2020) the pro-pounders of the GM theory analyzed growth mindset controversies as a modest defence that the mindset theory responds to challenges or setbacks, not to academic achievement in general. This theory predicts that mindsets should be associated with achievement, particularly among students facing challenges.

Under brain science research Electro Encephalography (EEG), a brain response assessing technique provided supportive pieces of evidence for a growth mindset. Moser and coworkers (Moser et al., 2011) studied performance-monitoring event-related potentials (the small voltage generated in brain structures in response to some events) and found the positive association of growth mindset with error positivity component (Pe) along with superior post-mistake accuracy. A difference in brain response patterns was found for fixed mindset and growth mindset girls in second grade during a go/no-go task (Ita Puusepp, 2019). The difference in error positivity was found larger for fixed-mindset girls.

1.2 Growth mindset interventions

The growth mindset interventions are implemented in different ways, spreading from a one-shot single session to ten sessions in a study (de Carvalho & Skipper, 2020) with a wide range of length per session from 25 minutes (Yeager et al., 2019) to two hours (Cinzia Rienzo et al., 2015) and by online session also. Most of the interventions used in growth mindset research comprised of one or more of the components– awareness of neuroanatomy, neuroplasticity, working of the brain, video clip show about the brain's capability to grow and make new connections, voiceover on scientific discoveries on brain growth in response to intellectual challenges, key concepts of implicit theory of intelligence; sharing of personal experiences of students and trainer and writing letters to others (Aronson et al., 2002; Blackwell et al., 2007; Good et al., 2003; Paunesku et al., 2015). A growth mindset-based intervention essentially has a GM awareness session as the main constituent of GM intervention. The other elements of growth mindset intervention are as follows –

1. Imparting brain plasticity awareness. An overall positive effect of teaching concepts of neuroplasticity (to induce a growth mindset) on motivation, achievement, and brain activity is witnessed in research studies (Sarrasin et al., 2018).
2. Use of process praise (praise for effort) instead of praise for outcome or intelligence (praise of person), e.g. praising problem-solving strategies, pointing out and complementing the progress

and development of a student.

3. Use the power of "yet" when a student did not progress up to his/ her expectations. The power of "yet" helps students to overcome their setbacks. Use of the wordings as - You are not good at …yet, you will master...
4. Process-focused teaching (progress monitoring, adapting instructions as needed).
5. Making communication in a format reflects positive views of effort.

1.3 Growth mindset and science anxiety

The effect of the growth mindset on science anxiety has not been studied in past. In the review of literature, the researcher found no direct study available regarding the effect of a growth mindset on science anxiety but other forms of student-related anxiety such as test anxiety, subject-specific anxiety, and maths anxiety have been studied. The students possessing a growth mindset have a moderate level of anxiety in General Mathematics (Mabandos & Moneva, 2020). The growth mindset interventions have been shown to reduce anxiety (Smith & Capuzzi, 2019), parent-reported adolescent anxiety (J. Schleider & Weisz, 2018), and math anxiety in a mixed-method study of combined mindfulness and growth mindset intervention (Samuel & Warner, 2021). The growth mindset intervention was found effective in making students' mindsets more growth-oriented (Smith & Capuzzi, 2019) and math self-efficacy (Samuel & Warner, 2021).

1.4 Growth mindset and academic stress

The growth mindset has been found to show a negative significant relationship with academic stress and students with a growth mindset have been found to perceive moderate stress, less fear of failure, and less personal inadequacy (Shalini, 2021). In this study, the dimensions of perceived stress and overall stress were found age-dependent. The relationship of a growth mindset with the stress of high school students is also supported by a scientific method (Lee et al., 2019). The students were surveyed daily for assessing negative stress and appraisals for the stress experienced. The study found a higher overall negative stress response as a higher level of salivary cortisol hormone (stress hormone) in fixed mindset high school students in comparison to growth mindset students during the phase when the grades of students were declining.

2.0 Emergence of the problem and Justification of the study

The education system due to the compulsion of performance exerts a lot of academic-related pressure on students. This pressure amplifies the stress and increases the anxiety in the learners and deteriorates their mental health.

Learning is the central goal of education. Students' mental health affects their learning in a positive relationship and the mental health of students is very important at the school level. The poor mental health of students correlates with their emotional, behavioural, and learning problems, and deterioration in their mental health may hinder students' success (VanderLind, 2017). In simple terms, mental health is defined as emotional well-being affected by depression, anxiety, and stress (Poh Keong et al., 2015) and it is positively related to academic achievement (Bas, 2021). Academic stress negatively affects the mental health of students (C. Subramani & S. Kadhiravan, 2017; Kaur & Puar, 2017). All the forms of anxiety in academics adversely affect the learning of students (Cassady & Johnson, 2002; Crişan & Copaci, 2015; Vitasari et al., 2010).

Deterioration of their mental health negatively affects the psychological well-being of students which pushes the students towards poor performance and at last towards failure. Scholastic setbacks of failure further reduce the chance of the bounce-back of challenges facing students. Such a situation hampers the learning goals of the students. Science anxiety and academic stress are associated with mental health and well-being-related affecting factors that hamper the learning goals of science students negatively and are hence important for students learning. During the review of literature for searching the ways to handle the mental health affecting factors, the researcher found an approach relevant, that is a growth mindset capable of changing the belief system of the students. An obvious curiosity that comes to mind is whether the change in belief is effective in reducing these factors. This arises the interest of the researcher to delve into the theory of growth mindset and whether the intervention based on this theory can change the belief system of students and is effective on the dependent variable taken under study.

2.1 Growth mindset study is a current research interest

The growth mindset is under investigation in several countries for its cross-cultural effect (Sun et al., 2021), validation and reliability studies (Midkiff et al., 2018), motivation (Bedford, 2017), academic

performance (Brougham & Kashubeck-West, 2017), learning engagement (Zhao et al., 2021), and psychological well being (Berlin, 2019; Iqbal et al., 2021; Zeng et al., 2016), etc.

2.2 Growth mindset has gained tremendous attention from the educational community

The concept of a growth mindset has gained much attention from the educational community that the OECD-PISA 2018 survey included it in the study.

2.3 Study is about the prevalent problem of the students

In Indian society, students are in a state of psychological stress and emotional pressure, as the education achieved is directly linked with status as it makes a way to their social recognition and their self-financial settlement. Further, the intensified competitive environment made the situation worsen. In a study by the Indian Council of Medical Research (ICMR) in 2005 it is unveiled that 12 % to 13 % of school students face emotional, behavioural, and learning problems such as anxiety, depression, learning difficulties, suicidal tendencies, etc (School Teachers to Be Trained to Identify Mental Health Issues among Students, 2021). Organization for Economic Co-operation and Development (OECD) - Program for International Student Assessment (PISA) 2015 report for students aged 15–16 years of 72 countries reported to – feel stressed about poor grades (66%), worried about difficulty in taking a test (59%), feel very anxious for a test even if they are well prepared (55%), get very tense when studying (37%), get nervous when they don't know how to solve a task at school (52%) (OECD-PISA Results Volume-III). The data makes the inference that academics-related anxiety, stress, and related issues are of utmost importance.

The data on suicidal cases among students is alarming as it reaches its highest in 2019 (8.2 %) since 1995 (Accidental Deaths and Suicides in India, 2020) and there is a need to investigate students' academic concerns about emotional, behavioural issues and their related problems in learning.

2.4 Effect of the independent variable on dependent variables is worth exploring as a growth mindset is expected to foster good mental health

A growth mindset positively affects mental health and persons having a growth mindset are less prone to mental health problems (Tao et al., 2022). A random-effects meta-analysis study revealed that fixed mindset youths show more pronounced mental health problems (J. L. Schleider et al., 2015). The growth mindset interventions are supposed to change the belief system of learners. The belief system

influences the perception of an individual and it plays an important role for a student in coping with an academic-related stressful situation, overcoming mental health issues, and bouncing back from setbacks. Self-beliefs also help a person in coping with mental health-related factors negatively affecting psychological well-being. Academics-related anxiety, stress, and related problems are important emotional, behavioural, and learning concerns of students which negatively affect students' well-being. Students' well-being globally gained such importance that OECD-PISA 2015 survey was based on this theme. In a recent meta-analytic study (Burnette, Knouse, et al., 2020) the growth mindsets are found to have a positive correlation to treatment value and active coping and a negative correlation with psychological distress (ie. symptoms of anxiety, depression, psychological stress, or absence of well-being).

2.5 Growth mindset to psychological distress link is more effective than growth mindset to academic achievement link

Interestingly the effect size for the growth mindset to psychological distress link (J. L. Schleider et al., 2015) was found twice the effect size for the growth mindsets and academic achievement link (Costa & Faria, 2018; Sisk et al., 2018). This conclusive inference that the growth mindset to psychological distress link is more effective than the academic achievement link makes the ground to explore the effect of GMI on mental health affecting psychological distress factors of students.

3.0 Research Questions

1. Whether a growth mindset-based intervention is effective on science anxiety of secondary-level students.
2. Whether a growth mindset-based intervention is effective on learning science anxiety of secondary-level students.
3. Whether a growth mindset-based intervention is effective on science evaluation anxiety of secondary-level students.
4. Whether a growth mindset-based intervention is effective on academic stress of secondary-level students.
5. Whether a growth mindset-based intervention is effective on cognitive demand factors of secondary-level students.

6. Whether a growth mindset-based intervention is effective on affective demand factors of secondary-level students.
7. Whether a growth mindset-based intervention is effective on physical demand factors of secondary-level students.
8. Whether a growth mindset-based intervention is effective on social-interpersonal demand factors of secondary-level students.
9. Whether a growth mindset-based intervention is effective on motivational demand factors of secondary-level students.

4.0 Statement of the problem

To study the effect of growth mindset-based intervention on science anxiety and academic stress of secondary-level students.

5.0 Operational definition of the terms

5.1 Growth Mindset

Dweck's theory of growth mindset conceptualized intelligence and skills as malleable (i.e. flexible) and dynamic (i.e. changeable) in nature. The basic tenet of the growth mindset theory is that the most basic innate abilities can be developed further through dedication and hard work.

For the proposed study, the growth mindset refers growth mindset of intelligence and it is defined as a belief that intelligence is malleable (i.e. flexible) and dynamic (i.e. changeable) in nature.

5.2 Science anxiety

Encyclopedia of Britannica defines anxiety, as a feeling of dread, fear, or apprehension, often with no clear justification (Anxiety | Psychology | Britannica, n.d.) and also distinguishes anxiety from fear as the fear aroused a clear sense of danger.

In the academic context, anxiety is differentiated as general anxiety, test anxiety, mathematics anxiety, foreign language learning anxiety, academic anxiety, and science anxiety.

Jaffery Mallow was the first to identify the science-related phenomenon of anxiety distinct from general and test/performance anxiety and he coined the term 'Science anxiety' and defined science anxiety as a debilitating interaction of emotion – fear with cognition – science learning (Mallow et al., 2010).

Megreya et al defined Science anxiety as students' negative emotions about learning science (Megreya et al., 2021).

For the proposed study, science anxiety is defined as a combination of negative emotions of secondary-level students factorized in form of anxiety towards learning science and anxiety towards science evaluation as measured in the Abbreviated Science Anxiety Scale (ASAS).

5.3 Academic stress

Stress is a term coined in 1936 by physician Hans Selye as the body's "non-specific reaction to demands made to its internal equilibrium." American Psychological Association dictionary defines stress as the physiological or psychological response to internal or external stressors (Stress – APA Dictionary of Psychology, n.d.). For a person, a situation that arose out of interaction with the environment may be perceived as stressful if it is appraised by him as being out of control because of his resource and hereby which could endanger his well-being (Lazarus & Folkman, 1984).

For academic settings, Wilks in line with Lazarus and Folkman defined academic stress as a product of the combination of academic-related demands that exceed the adaptive resources available to an individual (Wilks, 2008).

Suresh Prabhu defined academic stress as the anxiety and stress that comes from schooling and education (Prabu, 2015).

For the proposed study, academic stress is defined as a combination of five academic-related cognitive, affective, physical, social-interpersonal, and motivational demand factors of secondary level students as measured in the Scale for Assessing Academic Stress (Sinha et al., 2001).

5.4 Secondary-level students

The students of UP board studying science in 10^{th} class.

6.0 Variables of the Study

Table 1- Independent and dependent variables

Independent variable	Dependent variables
Growth mindset-based intervention	Science anxiety
	Academic stress

7.0 Main objectives of the Study

7.1 To study the effect of growth mindset-based intervention on science anxiety of secondary-level students.

7.2 To study the effect of growth mindset-based intervention on academic stress of secondary-level students.

8.0 Hypotheses of the Study

8.1 There will be a significant effect of growth mindset-based intervention on the science anxiety of secondary-level students.

8.2 There will be a significant effect of growth mindset-based intervention on the learning science anxiety of secondary-level students.

8.3 There will be a significant effect of growth mindset-based intervention on the science evaluation anxiety of secondary-level students.

8.4 There will be a significant effect of growth mindset-based intervention on the academic stress of secondary-level students.

8.5 There will be a significant effect of growth mindset-based intervention on the cognitive demand factor of secondary-level students.

8.6 There will be a significant effect of growth mindset-based intervention on the affective demand factor of secondary-level students.

8.7 There will be a significant effect of growth mindset-based intervention on the physical demand factor of secondary-level students.

8.8 There will be a significant effect of growth mindset-based intervention on the social-interpersonal demand factor of secondary-level students.

8.9 There will be a significant effect of growth mindset-based intervention on the motivational demand factor of secondary-level students.

9.0 Delimitations of the Study

9.1 This study will be limited to secondary school science stream students.

9.2 The selection of a school for the proposed study will be done on a purposive sampling basis.

9.3 This study will be limited to the geographical area of the Agra district.

9.4 This study will include only the Chemistry content in growth mindset-based intervention.

10.0 Framework of the proposed study

The proposed study is framed keeping in view the following research findings on growth mindset theory -

(i) Subject-specific, lesson-integrated mindset training is found to improve positive and stable training effects on growth mindsets (Zeeb et al., 2020). A chemistry course-based growth mindset intervention improved the General Chemistry performance of students (Fink et al., 2018). So in subject-specific environments, the validity of implicit theories will be more to gather data for this study.

(ii) The mindset theory by nature refers to responses to challenges or setbacks and that should be associated particularly with the challenge facing people (Yeager & Dweck, 2020). Chemistry is a difficult subject and understanding chemistry is a challenge for students at all levels due to its unique conceptual nature, and on the student's part, this is a subject of struggle. Further, the students do not find the relevance of chemistry content in their lives makes students' perception of their intelligence fixed (Wang et al., 2021). Specifically, the chemical concepts in Chemistry produce complexity for students and they divert from the subject and go towards low achievement and setbacks.

Keeping in view the domain specificity of the growth mindset and the challenging nature of Chemistry the proposed study is framed to implement chemistry lessons integrated with growth mindset intervention.

The theoretical framework of the study includes Carol Dweck's mindset theory.

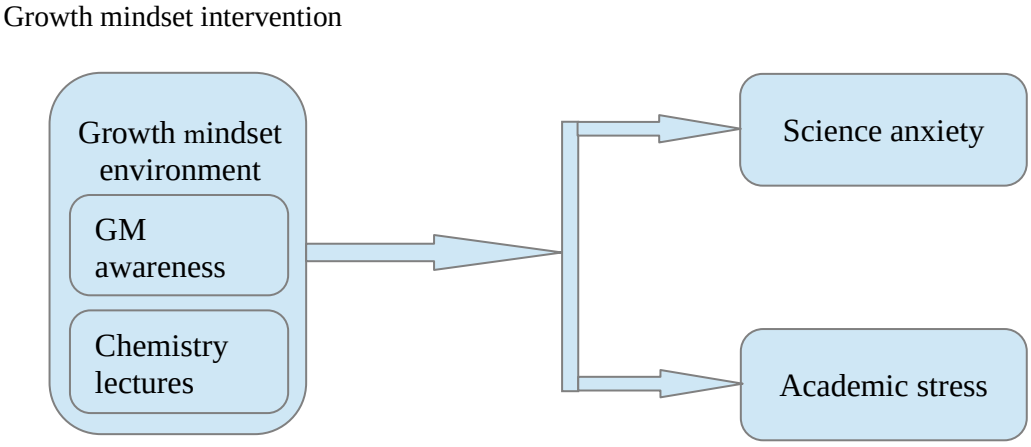

Figure 1. Framework of the proposed study

11.0 Research design

Quasi Experimental Design

The research design involves the implementation of a GM intervention in a subject-specific lesson-integrated classroom teaching environment. Quasi-experimental method of research is intended to be used in the proposed study as this method of research is the best suitable method for the present study as the random selection of participants in a class in an Indian education environment is not possible. Further putting some of the students in the same class in controlled conditions is also not possible. The research design having elements of Pre-test & Post-test, Non-equivalent group design intended to be used in the proposed study is illustrated in the following table –

Table 2 - Research design

Control group	Pre-test of the dependent variables science anxiety academic stress	No treatment give (Conventional learning)	Post-test of the dependent variables science anxiety academic stress	Comparison of Control \and treatment groups
Treatment Group	Pre-test of the dependent variables science anxiety academic stress	Treatment given (Growth Mindset based intervention)	Post-test of the dependent variables science anxiety academic stress	

11.1 Population of the study

The population for the proposed study will be secondary-level students of schools in the Agra district.

11.2 Sample of the Study

The intended total size of the sample is nearly 100 secondary-level science students from two sections of a school or two schools in Agra. Out of which, students from one section will comprise the experimental group and students from other section will comprise the controlled group. The experimental group will be given a growth mindset intervention and will be taught chemistry course content during their study under the growth mindset environment. The control group will be taught the same course content as the experimental group without a GMI treatment in the class.

11.3 Sampling procedure

Purposive sampling will be used for the selection of the school in the Agra district and further the sections of the class to form an experimental group and the control group will be selected randomly.

11.4 Data collection tools

11.4.1 Science anxiety

Popular tools to measure science anxiety are the Science Anxiety Questionnaire (SAQ) (J. V. Mallow, 1994) and the Science Anxiety Scale (SAS) (Güzeller & Doğru, 2012). A recent tool to measure scientific anxiety Abbreviated Science Anxiety Scale (ASAS) is also introduced (Megreya et al., 2021). The important features of the tools are listed in the following table –

Table 3 - Popular tools to measure science anxiety

Sr.	Name of the tool / Author	Profile
1.	Science Anxiety Questionnaire (SAQ) J. V. Mallow, 1994	1. University level 2. 44 self-report items (science anxiety and non-science anxiety for every 22 items) 3. measurement on a 5-point rating scale (not at all, a little, a fair amount, much, and very much) 4. internal consistency reliability (i) science anxiety, $\alpha = 0.90$ (ii) non-science anxiety, $\alpha = 0.85$
2.	Science Anxiety Scale (SAS) Güzeller & Doğru, 2012	1. primary level 2. 28 self-report items 3. measurement 5-point rating scale (I certainly agree, I agree, I am undecided, I do not agree) 4. measures two sub-dimensions (i) personal dimension and (ii) environment dimension 5. dimensional internal consistency reliability (i) personal, $\alpha = 0.94$ (ii) environment, $\alpha = 0.77$
3.	Abbreviated Science Anxiety Scale (ASAS) Megreya et al., 2021	1. VII to X standard 2. verbal test containing 09 items 3. measurement 5-point rating scale (No bad feelings; Somewhat bad; Moderate fearful, tense or nervous; Bad feelings; Very bad feelings) 4. measures two factors by self-rating the feeling of fear evaluated by students in some situations during the specified activities (i) learning science anxiety and (ii) science evaluation anxiety 5. internal consistency reliability for secondary level $\omega = 0.89$ 6. convergent validity: correlation with - (i) test anxiety = 0.56 and (ii) general anxiety = 0.58

The science anxiety of students will be assessed by the Abbreviated Science Anxiety Scale (ASAS) (Megreya et al., 2021). For one reason the Abbreviated Science Anxiety Scale (ASAS) is preferred over Science Anxiety Questionnaire (SAQ) and the Science Anxiety Scale (SAS) for its succinctness

and another reason is that ASAS is validated for seventh-grade to secondary students whereas SAQ is validated for university students and SAS validated for primary students.

11.4.2 Academic stress

Academic stress can be measured by the Perceptions of Academic Stress scale (PASS) (Bedewy & Gabriel, 2015), Stress Inventory for School Students (SISS), and Scale for Assessing Academic Stress (SAAS) (Sinha et al., 2001). The important features of the tools are listed in the following table –

Table 4 - Popular tools to measure academic stress

Sr.	Name of the tool/ Author	Profile
1.	Scale for Assessing Academic Stress (SAAS) Uday K. Sinha et al., 2001	1. VIII to XII standard 2. self-reported 30 items yes/ no type 3. measures five factors (i) cognitive (ii) affective (iii) physical (iv) social/ interpersonal and (v) motivational factors 4. Reliability – (i) test-retest reliability over one month = 0.88 (ii) split-half reliability = 0.75 5. validated against Academic Anxiety Scale for Children (AASC) and Beck Depression Inventory (BDI)
2.	Stress Inventory for School Students (SISS) Basant Bahadur Singh & Seema Rani, 2008	1. 6 – 14 years, pre-secondary students 2. self-reported 30 item 3. measurement on a four-point scale (i) very worried (ii) worried (iii) little worried (iv) Not worried. 4. test-retest reliability after 14 days = 0.80 internal consistency reliability by odd-even method = 0.79 content validity is adequate
3.	Perceptions of Academic Stress scale (PASS) Bedewy & Gabriel, 2015	1. University level 2. Self-reported 18 items 3. measurement on a five-point scale of 1 (Totally disagree) to 5 (Totally agree) 4. measures four factors – (i) Pressures to perform (ii) Perceptions of workload (iii) Academic Self-Perception (iv) Time restraints 5. internal consistency reliability $\alpha = 0.70$

For its simplicity of use, the Scale for Assessing Academic Stress (SAAS) developed by Uday K. Sinha and co-workers (Sinha et al., 2001) will be used in this study. This scale was standardized on a sample of 400 high school and college students of different grades (grades VIII to XII) in Nepal. The scale will be revalidated and will be accessed for its reliability.

11.5 Statistical analysis

The paired samples t-test will be conducted within the group and for assessing intervention effectiveness independent sample t-test will be conducted between the control group and the experiment group.

11.6 Planned growth mindset based intervention

In short, the elements of the growth mindset intervention intended to be used are as follows -

(1) Growth mindset awareness session

Class awareness lecture to address answers to the following question -

(a) Introduction of the word mindset, what is fixed mindset, what is the growth mindset? what is the difference between a fixed mindset and a growth mindset?

(b) What is the neural structure of the brain? What are neurons? How brain process information? How can they change over time? How do we know this? What is brain malleability? What is neuroplasticity and How it works? How our brains can be rewired? What are our brains like muscles and they could be made stronger? (This section of the lecture will be backed with a discussion on an article about brain research with the students and a brief of the latest research findings in the field).

(c) What is creative thinking?

(d) What are different tools that can be used to keep a growth mindset -

(2) Activities to be performed during this session –

(a) Growth mindset quiz

(b) Students' self-discussion over the mindset and their own experience sharing in groups if they have any experience regarding making their brain smarter.

(c) Own storytelling to get students' attention for the words – Hard work, Strategies, Help from others.

(d) Self-assessment of students for their growth mindset barriers and a plan to overcome these barriers after class lecture spell. Fortnightly self-assessment of students for their progress and teacher's feedback.

(e) The students will be asked to write a letter giving helpful advice to their friend struggling based on what they learned from the awareness session (Paunesku et al., 2015).

(f) Showing videos regarding growth mindset.

(3) Creating a Growth Mindset environment in the classroom

A growth mindset environment in the classroom will be maintained as follows -

(a) Use of growth mindset Language including growth mindset-focused vocabulary in the classroom. Visual display of growth-mindset vocabulary in inspirational posters.

(b) Effort will be praised, Not the outcomes. Compliments will be made for the hard work and progress of students, not for their grades or scores achieved.

(c) Group learning opportunities in the classroom involving a cooperative environment rather than competitive or individual learning work will be provided.

(d) Emphasis will be made on the learning process (like practicing, asking for help, or trying new strategies) rather than making emphasis on intellect or talent.

(e) The students will be given attainable challenges and will be given opportunities to face obstacles.

(g) The students will be taught to accept constructive criticism.

(h) Use the power of "Yet" to encourage learning, maintain engagement, and increase confidence in students.

(i) Display of posters fostering the impact of growth mindset theory.

(4) Chemistry lectures session

In this phase, the chemistry classroom lectures will be delivered with GM feedback and a GM environment in class.

This session will involve such chemistry topics included in the curriculum of the 10^{th} class which requires a deep understanding of tough concepts of chemistry. The following topics will be covered from unit 1 of the syllabus of the 10^{th} class of the UP board –

रासायनिक अभिक्रियाएँ - रासायनिक समीकरण, संतुलित रासायनिक समीकरण, संतुलित रासायनिक समीकरण का तात्पर्य, संतुलित रासायनिक अभिक्रियाओं के प्रकार- संयोजन अभिक्रिया, अपघटन (वियोजन) अभिक्रिया, विस्थापन अभिक्रिया, द्विविस्थापन अभिक्रिया, अवक्षेपण अभिक्रिया, उदासीनीकरण, उपचयन तथा अपचयन अभिक्रिया।

अम्ल, क्षार तथा लवण H^+ तथा OH^- आयनों के आधार पर अम्ल, क्षार तथा लवण की परिभाषाएँ, सामान्य गुणधर्म, उदाहरण तथा उपयोग, pH पैमाना की अवधारणा, दैनिक जीवन में pH का महत्त्व।

11.7 Pre-Post Testing & Intervention implementation Plan

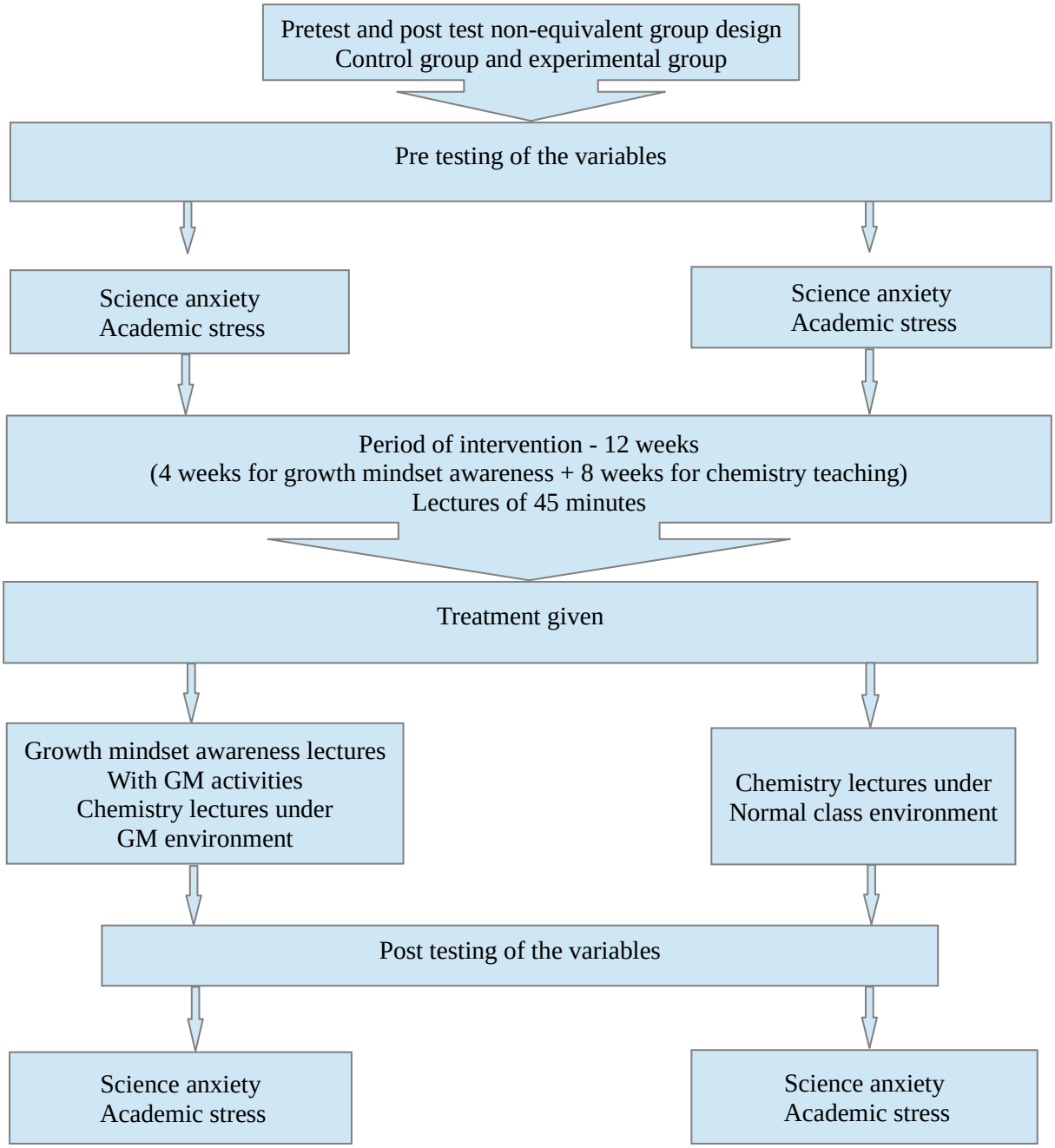

Figure 2. Pre-Post Testing & Intervention implementation Plan

Timeline of GMI

The period of intervention will be 12 weeks –

(i) 4 weeks - of growth mindset awareness

(ii) 8 weeks - of chemistry teaching under the growth mindset environment

Table 5 - Timeline of GM intervention

First week		Reference
Day 1	Introduction – mindset Types of mindset - fixed mindset and growth mindset	
Day 2	Difference between a fixed mindset and a growth mindset	
Day 3	Poster presentation of fixed mindset and growth mindset	
Day 4	Discussion of students over mindset in groups	
Day 5	Sharing of own experience of students making their brains smarter in groups.	
Day 6	Article sharing with students over the growth mindset – You can grow your brain	(Paunesku et al., 2015)
Second week		
Day 1	Brain anatomy, Neural structure of the brain – Neurons, neurotransmission, and information processing in the brain	(Blackwell et al., 2007; Good et al., 2003)
Day 2	Change in neural network - Change over time, scientific evidence	
Day 3	Neuroplasticity - What is brain malleability? - Brain rewiring and change in neural network	
Day 4	Brief of latest findings in the neuroplasticity field.	
Day 5	Discussion of students over neuroplasticity in groups	
Day 6	Students summary writing of the scientific findings on neuroplasticity in their own words	(Paunesku et al., 2015)
	Comprehensive quiz over neuroplasticity	
	Self-assessment of students for their progress and teacher's feedback.	
Third week: Growth mindset tools to keep a growth mindset		
Day 1	Taking challenges, Grit as a requirement for success	
Day 2	Persistence & Hard Work	
Day 3	Making Mistakes & Resilience, the storytelling of Edison and Ford. I have not failed. I've just found 10,000 ways that won't work – Thomas Edison The only real mistake is the one from which we learn nothing – Henry Ford	
Day 4	Creative thinking	
Day 5	Growth mindset video show	(Aronson et al., 2002)
Day 6	Growth mindset quiz	
Fourth week		
Day 1	Discussions over how learning makes students smarter	(Blackwell et al., 2007)
Day 2	Study Skills Lesson - Effective Listening, Effective Reading	
Day 3	Study Skills Lesson - Effective Writing, Improving Vocabulary, Time	

	Management	
Day 4	Self-assessment of students for their growth mindset barriers and writing a plan to overcome these barriers	
Day 5	Letter writing from students for helpful advice to his/ her struggling friend based on learning from the awareness session.	(Paunesku et al., 2015)
Day 6	Self-assessment of students for their progress and teacher's feedback.	

12.0 Significance of the Study

During the education of students, fixed mindset beliefs, and setbacks in form of failures tend to produce low achievement. The fixed mindset beliefs can give rise to demotivation, can provoke disappointment, and can disturb self-image, self-knowledge, and self-awareness. Learning is the central goal of education. Science anxiety and academic stress of students are all necessary student-related elements for science education. Cultivation of scientific views and understanding of concepts in science students is a must for their future carrier. Research studies indicate the need for subject lesson-integrated growth mindset intervention for improving the learning outcome of the students. This study is probably the first in the Indian context to study the effect of subject-lesson integrated growth mindset intervention on student-related factors must for science learning. If the proposed study finds a reducing effect of GMI on science anxiety and academic stress of students then GM-based classes may be conducted by teachers for improving the future academic success of students. The school administrators may plan for creating a growth mindset environment in the school for benefit of the students. The proposed research work will study growth mindset in Indian classrooms set up under the Indian socio-cultural context and will contribute to growth mindset research which is a less researched field in India.

REFERENCES

Accidental Deaths and Suicides in India. (2020). National Crime Records Bureau. https://ncrb.gov.in/en/ADSI-2020

Anxiety | psychology | Britannica. (n.d.). Retrieved December 31, 2021, from https://www.britannica.com/science/anxiety

Aronson, J., Fried, C. B., & Good, C. (2002). Reducing the Effects of Stereotype Threat on African American College Students by Shaping Theories of Intelligence. *Journal of Experimental Social*

Psychology, *38*(2), 113–125. https://doi.org/10.1006/jesp.2001.1491

Bas, G. (2021). Relation between Student Mental Health and Academic Achievement Revisited: A Meta-Analysis. In *Health and Academic Achievement—New Findings*. IntechOpen. https://doi.org/10.5772/intechopen.95766

Bedewy, D., & Gabriel, A. (2015). Examining perceptions of academic stress and its sources among university students: The Perception of Academic Stress Scale. *Health Psychology Open*, *2*(2), 2055102915596714. https://doi.org/10.1177/2055102915596714

Bedford, S. (2017). Growth mindset and motivation: A study into secondary school science learning. *Research Papers in Education*, *32*(4), 424–443. https://doi.org/10.1080/02671522.2017.1318809

Berlin, K. (2019). *The Relationship Between Growth Mindset and Students' Psychological Well-Being* [University of Dayton]. http://rave.ohiolink.edu/etdc/view?acc_num=dayton1548856024417893

Bettinger, E., Ludvigsen, S., Rege, M., Solli, I. F., & Yeager, D. (2018). Increasing perseverance in math: Evidence from a field experiment in Norway. *Journal of Economic Behavior & Organization*, *146*, 1–15. https://doi.org/10.1016/j.jebo.2017.11.032

Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit Theories of Intelligence Predict Achievement Across an Adolescent Transition: A Longitudinal Study and an Intervention. *Child Development*, *78*(1), Article 1. https://doi.org/10.1111/j.1467-8624.2007.00995.x

Brougham, L., & Kashubeck-West, S. (2017). Impact of a Growth Mindset Intervention on Academic Performance of Students at Two Urban High Schools. *Professional School Counseling*, *21*(1), 2156759X18764934. https://doi.org/10.1177/2156759X18764934

Burnette, J. L., Hoyt, C. L., Russell, V. M., Lawson, B., Dweck, C. S., & Finkel, E. (2020). A Growth Mind-Set Intervention Improves Interest but Not Academic Performance in the Field of Computer Science. *Social Psychological and Personality Science*, *11*(1), 107–116. https://doi.org/10.1177/1948550619841631

Burnette, J. L., Knouse, L. E., Vavra, D. T., O'Boyle, E., & Brooks, M. A. (2020). Growth mindsets and psychological distress: A meta-analysis. *Clinical Psychology Review*, *77*, 101816. https://doi.org/10.1016/j.cpr.2020.101816

C. Subramani & S. Kadhiravan. (2017). Academic Stress And Mental Health Among High School

Students. *Indian Journal of Applied Research(IJAR), IJAR | World Wide Journals, VII*(V), 404–406.

Cassady, J. C., & Johnson, R. E. (2002). Cognitive Test Anxiety and Academic Performance. *Contemporary Educational Psychology*, *27*(2), 270–295. https://doi.org/10.1006/ceps.2001.1094

Cinzia Rienzo, Heather Rolfe, & David Wilkinson. (2015). *Changing Mindsets*. National Institute of Economic and Social Research. https://www.niesr.ac.uk/publications/changing-mindsets

Costa, A., & Faria, L. (2018). Implicit Theories of Intelligence and Academic Achievement: A Meta-Analytic Review. *Frontiers in Psychology*, *9*, 829. https://doi.org/10.3389/fpsyg.2018.00829

Crişan, C., & Copaci, I. (2015). The Relationship between Primary School Childrens' Test Anxiety and Academic Performance. *Procedia - Social and Behavioral Sciences*, *180*, 1584–1589. https://doi.org/10.1016/j.sbspro.2015.02.311

de Carvalho, E., & Skipper, Y. (2020). A two-component growth mindset intervention for young people with SEND. *Journal of Research in Special Educational Needs*, *20*(3), 195–205. https://doi.org/10.1111/1471-3802.12472

Demarin, V., Morović, S., & Bene, R. (2014). Neuroplasticity. *Periodicum Biologorum*, *116*(2), 209–211.

Dweck, C. S. (2006). *Mindset: The New Psychology of Success*. bahadur.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, *95*, 256–273.

Dweck, C. S., & Yeager, D. S. (2019). Mindsets: A View From Two Eras. *Perspectives on Psychological Science*, *14*(3), 481–496. https://doi.org/10.1177/1745691618804166

Ganimian, A. J. (2020). Growth-Mindset Interventions at Scale: Experimental Evidence From Argentina. *Educational Evaluation and Policy Analysis*, *42*(3), 417–438. https://doi.org/10.3102/0162373720938041

Good, C., Aronson, J., & Inzlicht, M. (2003). Improving adolescents' standardized test performance: An intervention to reduce the effects of stereotype threat. *Journal of Applied Developmental Psychology*, *24*(6), 645–662. https://doi.org/10.1016/j.appdev.2003.09.002

Iqbal, N., Hassan, B., Jadoon, S., & Ehsen, N. (2021). Association of School Engagement, Well-being, Resilience, and Growth Mindset Among Adolescents in High School. *Pakistan Journal of*

Psychological Research, 631–644.

Ita Puusepp. (2019). Mindsets and Failures: Neural Differences in Reactions to Mistakes among Second-Grade Finnish Girls. In Tuisku Tammi (Ed.), & Teija Kujala (Trans.), *Behavioral Neuroscience* (p. Ch. 5). IntechOpen. https://doi.org/10.5772/intechopen.85421

Kaur, G., & Puar, S. S. (2017). Relationship Between Mental Health And Academic Stress Of Senior Secondary School Students. *International Journal of Education*, *7*, 7.

Lazarus, R. S., & Folkman, S. (1984). *Stress, Appraisal, and Coping*. Springer Publishing Company.

Lee, H. Y., Jamieson, J. P., Miu, A. S., Josephs, R. A., & Yeager, D. S. (2019). An Entity Theory of Intelligence Predicts Higher Cortisol Levels When High School Grades Are Declining. *Child Development*, *90*(6), 849–867. https://doi.org/10.1111/cdev.13116

Li, Y., & Bates, T. C. (2019). You can't change your basic ability, but you work at things, and that's how we get hard things done: Testing the role of growth mindset on response to setbacks, educational attainment, and cognitive ability. *Journal of Experimental Psychology: General*, *148*(9), 1640–1655. https://doi.org/10.1037/xge0000669

Mabandos, S. M. Y., & Moneva, J. C. (2020). Students' Mindset and Level of Anxiety for General Mathematics among Grade 11 Students: A Case of Jagobiao National High School, Philippines. *IRA International Journal of Education and Multidisciplinary Studies*, *16*(1), 28–35. https://doi.org/10.21013/jems.v16.n1.p6

Mallow, J., Kastrup, H., Bryant, F. B., Hislop, N., Shefner, R., & Udo, M. (2010). Science Anxiety, Science Attitudes, and Gender: Interviews from a Binational Study. *Journal of Science Education and Technology*, *19*(4), 356–369. https://doi.org/10.1007/s10956-010-9205-z

Megreya, A. M., Szűcs, D., & Moustafa, A. A. (2021). The Abbreviated Science Anxiety Scale: Psychometric properties, gender differences and associations with test anxiety, general anxiety and science achievement. *PLOS ONE*, *16*(2), 1–20. https://doi.org/10.1371/journal.pone.0245200

Midkiff, B., Langer, M., Demetriou, C., & Panter, A. T. (2018). An IRT Analysis of the Growth Mindset Scale. In M. Wiberg, S. Culpepper, R. Janssen, J. González, & D. Molenaar (Eds.), *Quantitative Psychology* (pp. 163–174). Springer International Publishing. https://doi.org/10.1007/978-3-319-77249-3_14

Mosanya, M. (2021). Buffering Academic Stress during the COVID-19 Pandemic Related Social Isolation: Grit and Growth Mindset as Protective Factors against the Impact of Loneliness. *International Journal of Applied Positive Psychology*, *6*(2), 159–174. https://doi.org/10.1007/s41042-020-00043-7

Moser, J. S., Schroder, H. S., Heeter, C., Moran, T. P., & Lee, Y.-H. (2011). Mind Your Errors: Evidence for a Neural Mechanism Linking Growth Mind-Set to Adaptive Posterror Adjustments. *Psychological Science*, *22*(12), 1484–1489. https://doi.org/10.1177/0956797611419520

Orosz, G., Péter-Szarka, S., Bőthe, B., Tóth-Király, I., & Berger, R. (2017). How Not to Do a Mindset Intervention: Learning from a Mindset Intervention among Students with Good Grades. *Frontiers in Psychology*, *8*, 311. https://doi.org/10.3389/fpsyg.2017.00311

Paunesku, D., Walton, G. M., Romero, C., Smith, E. N., Yeager, D. S., & Dweck, C. S. (2015). Mind-Set Interventions Are a Scalable Treatment for Academic Underachievement. *Psychological Science*, *26*(6), 784–793. https://doi.org/10.1177/0956797615571017

Poh Keong, P., Pua, Sern, C., Lai, Lee, M. F., & Che Ibrahim, A. (2015, April 20). *The Relationship between Mental Health and Academic Achievement among University Students – A Literature Review*.

Prabu, S. (2015). A Study on Academic Stress among Higher Secondary Students. *International Journal of Humanities and Social Science Invention*, *4*(10), 63–68.

Rhew, E., Piro, J. S., Goolkasian, P., & Cosentino, P. (2018). The effects of a growth mindset on self-efficacy and motivation. *Cogent Education*, *5*(1), 1492337. https://doi.org/10.1080/2331186X.2018.1492337

Romero, C., Master, A., Paunesku, D., Dweck, C., & Gross, J. (2014). Academic and Emotional Functioning in Middle School: The Role of Implicit Theories. *Emotion (Washington, D.C.)*, *14*(2), 227–234. https://doi.org/10.1037/a0035490

Samuel, T. S., & Warner, J. (2021). "I Can Math!": Reducing Math Anxiety and Increasing Math Self-Efficacy Using a Mindfulness and Growth Mindset-Based Intervention in First-Year Students. *Community College Journal of Research and Practice*, *45*(3), 205–222. https://doi.org/10.1080/10668926.2019.1666063

Sarrasin, J. B., Nenciovici, L., Foisy, L.-M. B., Allaire-Duquette, G., Riopel, M., & Masson, S. (2018).

Effects of teaching the concept of neuroplasticity to induce a growth mindset on motivation, achievement, and brain activity: A meta-analysis. *Trends in Neuroscience and Education*, *12*, 22–31. https://doi.org/10.1016/j.tine.2018.07.003

Schleider, J. L., Abel, M. R., & Weisz, J. R. (2015). Implicit theories and youth mental health problems: A random-effects meta-analysis. *Clinical Psychology Review*, *35*, 1–9. https://doi.org/10.1016/j.cpr.2014.11.001

Schleider, J., & Weisz, J. (2018). A single-session growth mindset intervention for adolescent anxiety and depression: 9-month outcomes of a randomized trial. *Journal of Child Psychology and Psychiatry*, *59*(2), 160–170. https://doi.org/10.1111/jcpp.12811

School teachers to be trained to identify mental health issues among students. (2021, November 25). Hindustan Times. https://www.hindustantimes.com/india-news/schoolteachers-to-be-trained-to-identify-mental-health-issues-among-students-101637812046586.html

Shalini, J. F. (2021). *A STUDY ON ACADEMIC STRESS AND GROWTH MINDSET AMONG GRADUATE AND POST GRADUATE* (No. 02). *12*(02), Article 02.

Sinha, U. K., Shrama, V., & Nepal, M. K. (2001). Development of a scale for assessing academic stress: A preliminary report. *Journal of Institute of Medicine*, *23*(1 & 2).

Sisk, V. F., Burgoyne, A. P., Sun, J., Butler, J. L., & Macnamara, B. N. (2018). To What Extent and Under Which Circumstances Are Growth Mind-Sets Important to Academic Achievement? Two Meta-Analyses. *Psychological Science*, *29*(4), 549–571. https://doi.org/10.1177/0956797617739704

Smith, T. F., & Capuzzi, G. (2019). Using a Mindset Intervention to Reduce Anxiety in the Statistics Classroom. *Psychology Learning & Teaching*, *18*(3), 326–336. https://doi.org/10.1177/1475725719836641

Stress – APA Dictionary of Psychology. (n.d.). Retrieved January 3, 2022, from https://dictionary.apa.org/stress

Sun, X., Nancekivell, S., Gelman, S. A., & Shah, P. (2021). Growth mindset and academic outcomes: A comparison of US and Chinese students. *Npj Science of Learning*, *6*(1), Article 1. https://doi.org/10.1038/s41539-021-00100-z

Tao, W., Zhao, D., Yue, H., Horton, I., Tian, X., Xu, Z., & Sun, H.-J. (2022). The Influence of Growth

Mindset on the Mental Health and Life Events of College Students. *Frontiers in Psychology*, *13*, 821206. https://doi.org/10.3389/fpsyg.2022.821206

VanderLind, R. (2017). Effects of Mental Health on Student Learning. *The Learning Assistance Review*, *22*(2), 39–58.

Vitasari, P., Wahab, M. N. A., Othman, A., Herawan, T., & Sinnadurai, S. K. (2010). The Relationship between Study Anxiety and Academic Performance among Engineering Students. *Procedia - Social and Behavioral Sciences*, *8*, 490–497. https://doi.org/10.1016/j.sbspro.2010.12.067

Wang, Y., Rocabado, G. A., Lewis, J. E., & Lewis, S. E. (2021). Prompts to Promote Success: Evaluating Utility Value and Growth Mindset Interventions on General Chemistry Students' Attitude and Academic Performance. *Journal of Chemical Education*. https://doi.org/10.1021/acs.jchemed.0c01497

Wilks, S. E. (2008). Resilience amid Academic Stress: The Moderating Impact of Social Support among Social Work Students. *Advances in Social Work*, *9*(2), Article 2. https://doi.org/10.18060/51

Xu, K. M., Koorn, P., de Koning, B., Skuballa, I. T., Lin, L., Henderikx, M., Marsh, H. W., Sweller, J., & Paas, F. (2021). A growth mindset lowers perceived cognitive load and improves learning: Integrating motivation to cognitive load. *Journal of Educational Psychology*, *113*(6), 1177–1191. https://doi.org/10.1037/edu0000631

Yeager, D. S., & Dweck, C. S. (2020). What can be learned from growth mindset controversies? *American Psychologist*, *75*(9), 1269–1284. https://doi.org/10.1037/amp0000794

Yeager, D. S., Hanselman, P., Walton, G. M., Murray, J. S., Crosnoe, R., Muller, C., Tipton, E., Schneider, B., Hulleman, C. S., Hinojosa, C. P., Paunesku, D., Romero, C., Flint, K., Roberts, A., Trott, J., Iachan, R., Buontempo, J., Yang, S. M., Carvalho, C. M., … Dweck, C. S. (2019). A national experiment reveals where a growth mindset improves achievement. *Nature*, *573*(7774), 364–369. https://doi.org/10.1038/s41586-019-1466-y

Zeeb, H., Ostertag, J., & Renkl, A. (2020). Towards a Growth Mindset Culture in the Classroom: Implementation of a Lesson-Integrated Mindset Training. *Education Research International*, *2020*, e8067619. https://doi.org/10.1155/2020/8067619

Zeng, G., Hou, H., & Peng, K. (2016). Effect of Growth Mindset on School Engagement and

Psychological Well-Being of Chinese Primary and Middle School Students: The Mediating Role of Resilience. *Frontiers in Psychology, 7*, 1873. https://doi.org/10.3389/fpsyg.2016.01873

Zhao, H., Xiong, J., Zhang, Z., & Qi, C. (2021). Growth Mindset and College Students' Learning Engagement During the COVID-19 Pandemic: A Serial Mediation Model. *Frontiers in Psychology*, *12*, 224. https://doi.org/10.3389/fpsyg.2021.621094